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(54) **OPTICAL TRANSCEIVER HAVING BAIL WORKING INDEPENDENTLY OF LINEAR MOTION OF SLIDER**

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USPC 385/53, 88–92
See application file for complete search history.

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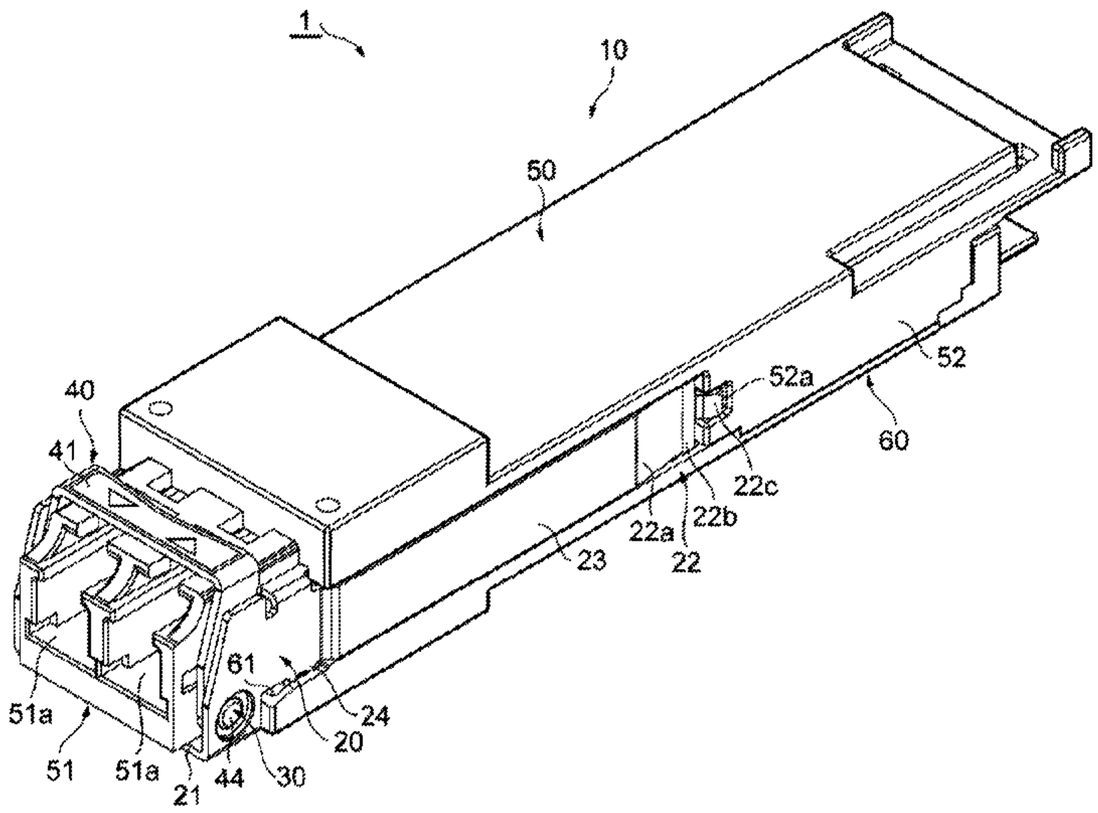
(57) **ABSTRACT**

A mechanism for an optical transceiver to latch with and release from a cage is disclosed. The mechanism includes a bail rotatable around an axis and a slider linearly movable between the latching position and the releasing position. The rotation of bail is independent of the liner motion of the slider.

11 Claims, 9 Drawing Sheets



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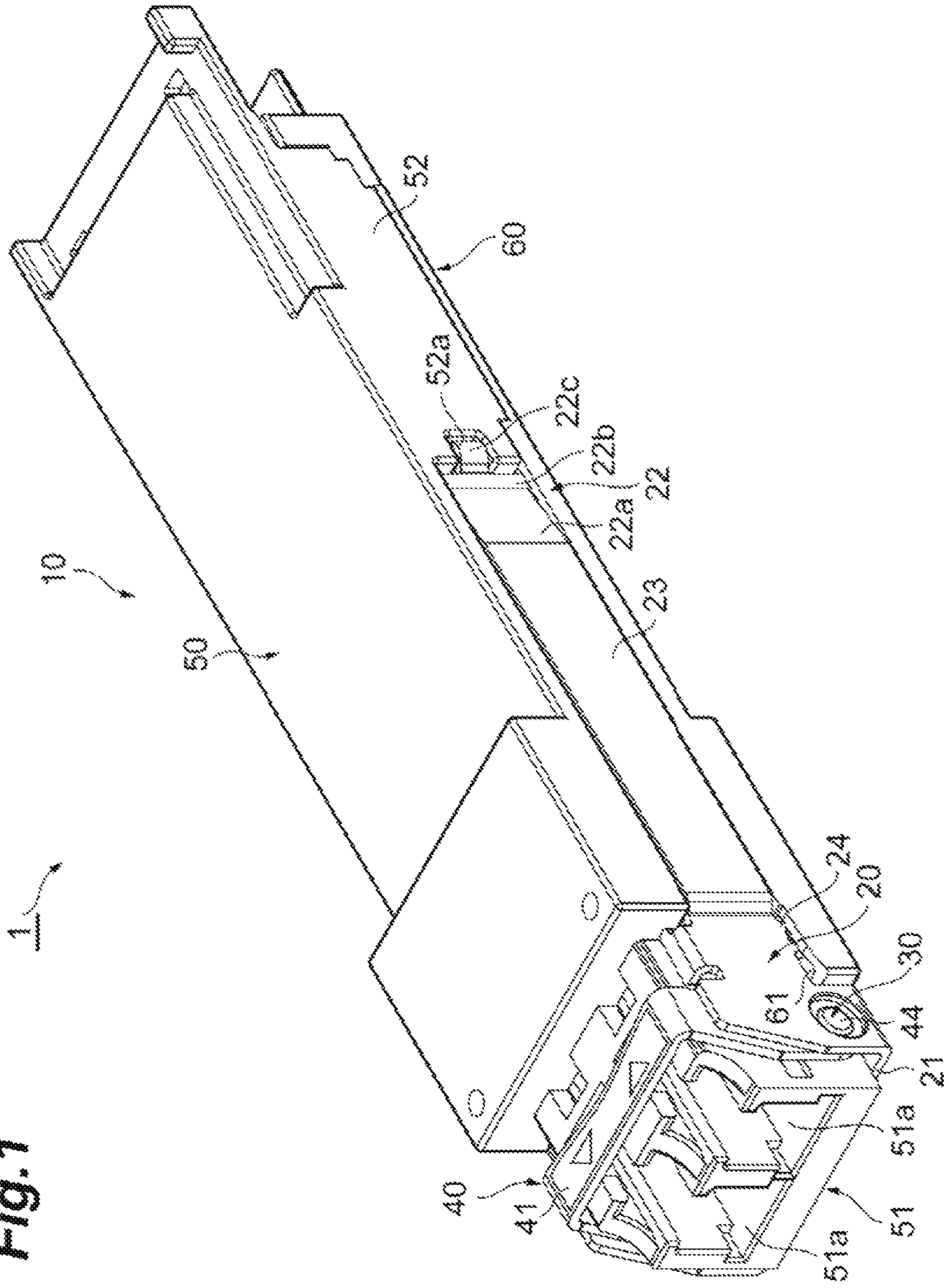
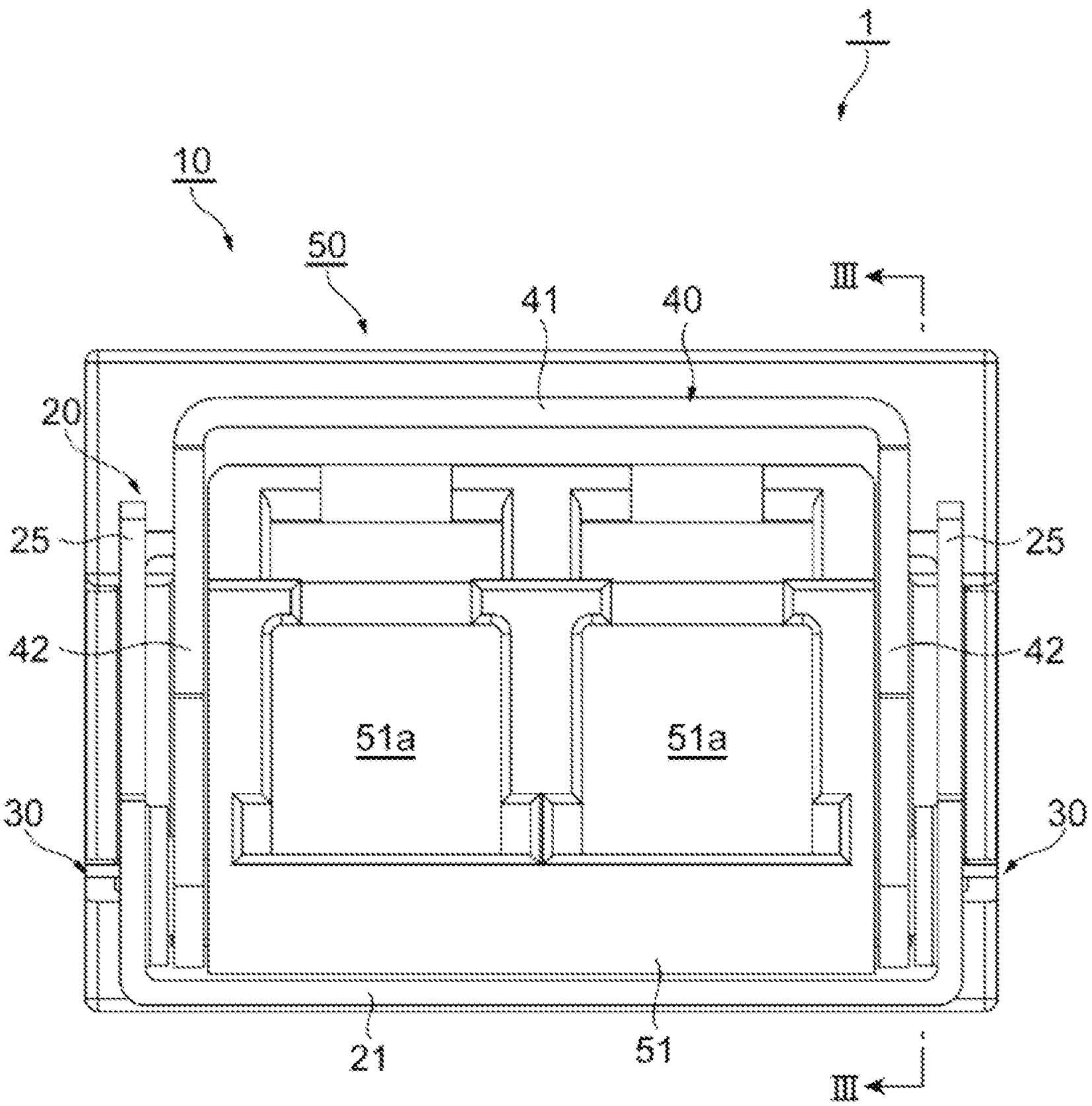

1
10
50
52
60
52a
22c
22b
22a
22
23
24
20
30
61
44
21
51a
51
51a
40
41
0

Fig.1

Fig.2



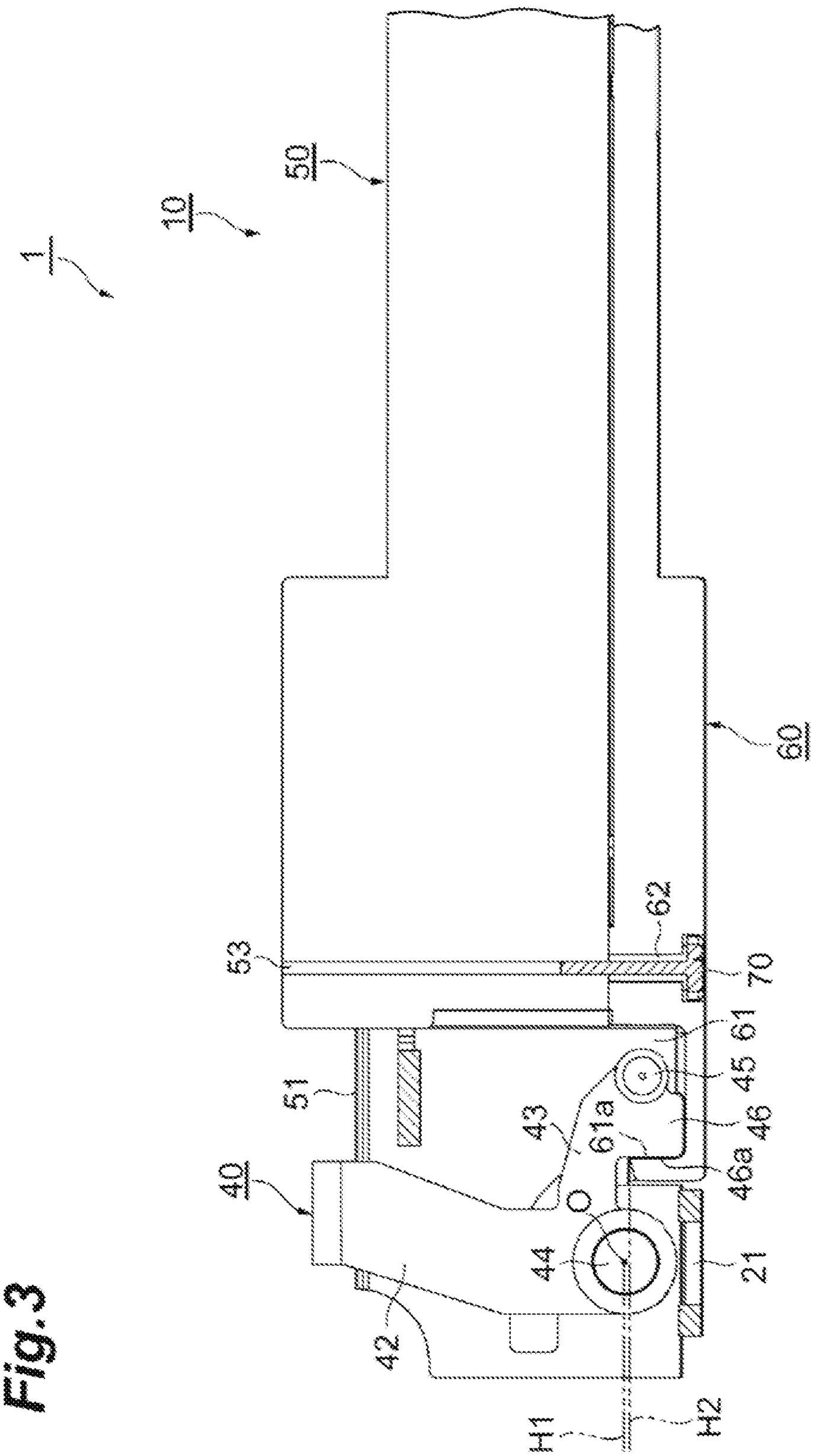
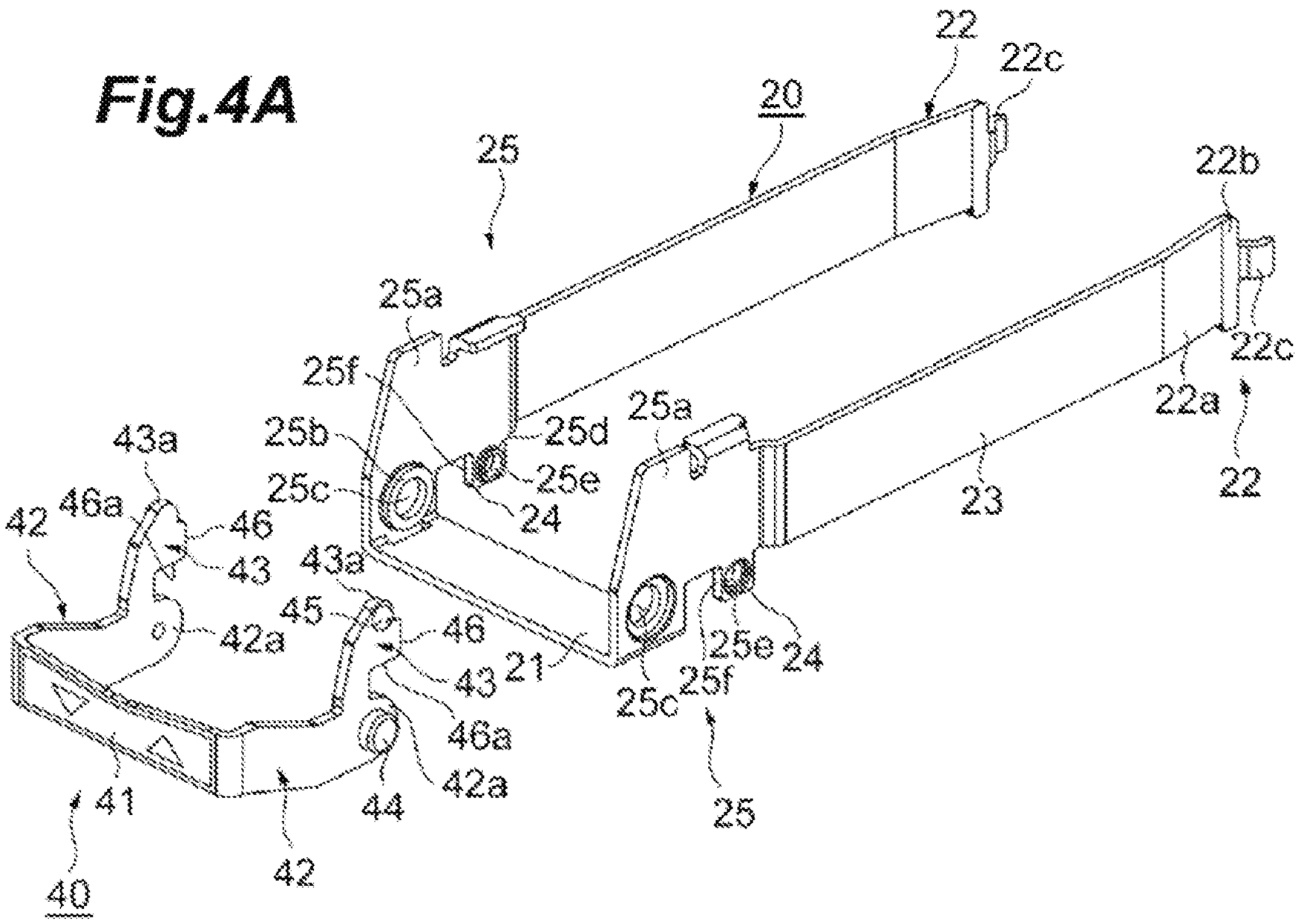


Fig.3

Fig.4A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22c
20
25
22b
25a
25f
25b
25d
25a
43a
25e
22c
22a
25c
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23
22
42
46a
46
43
43a
45
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25e
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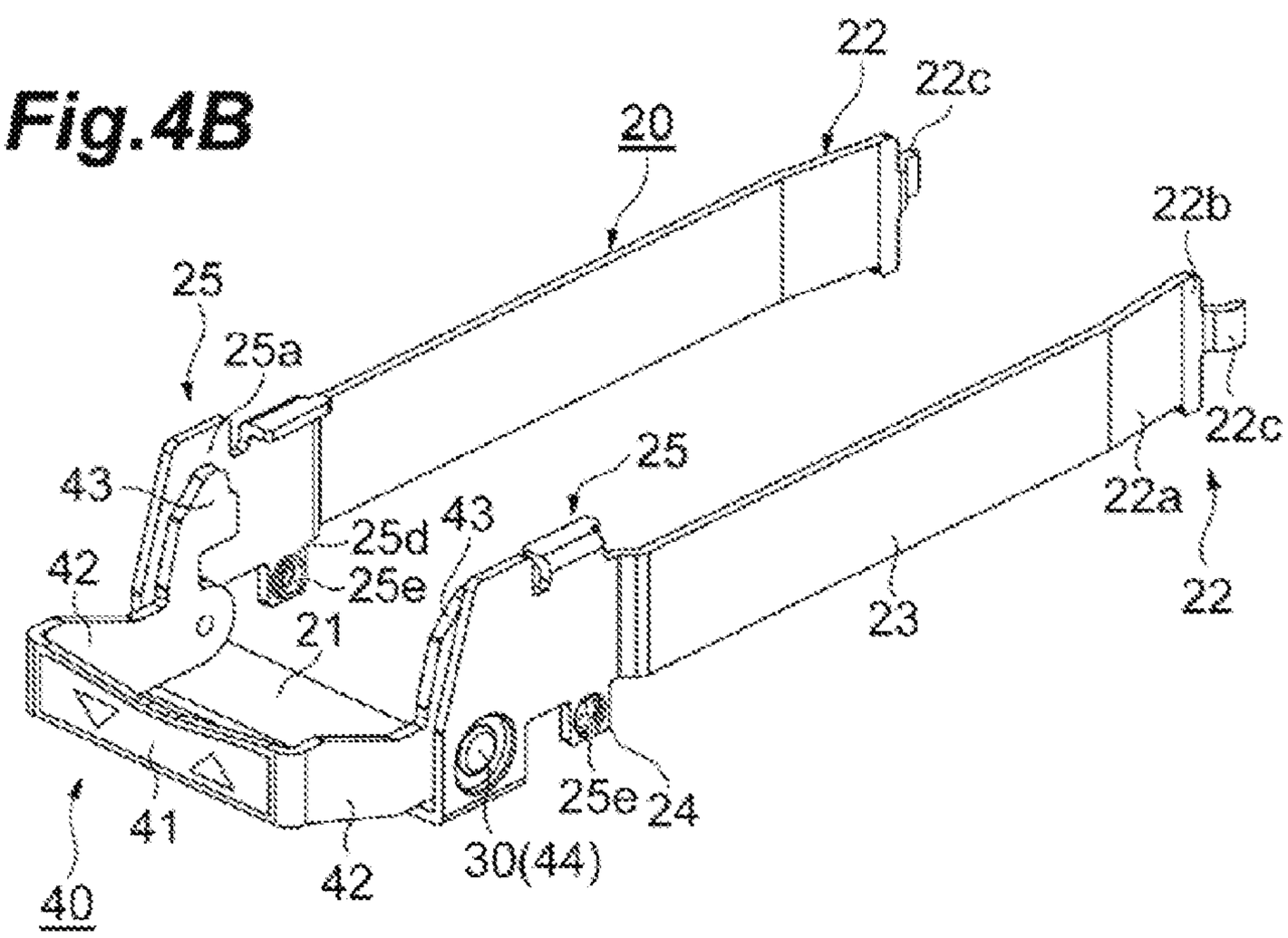
25c
25f
43
46a
42a
41
44
25
42
40

Fig.4B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25a
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22a
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23
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41
25e
24
42
30(44)
40

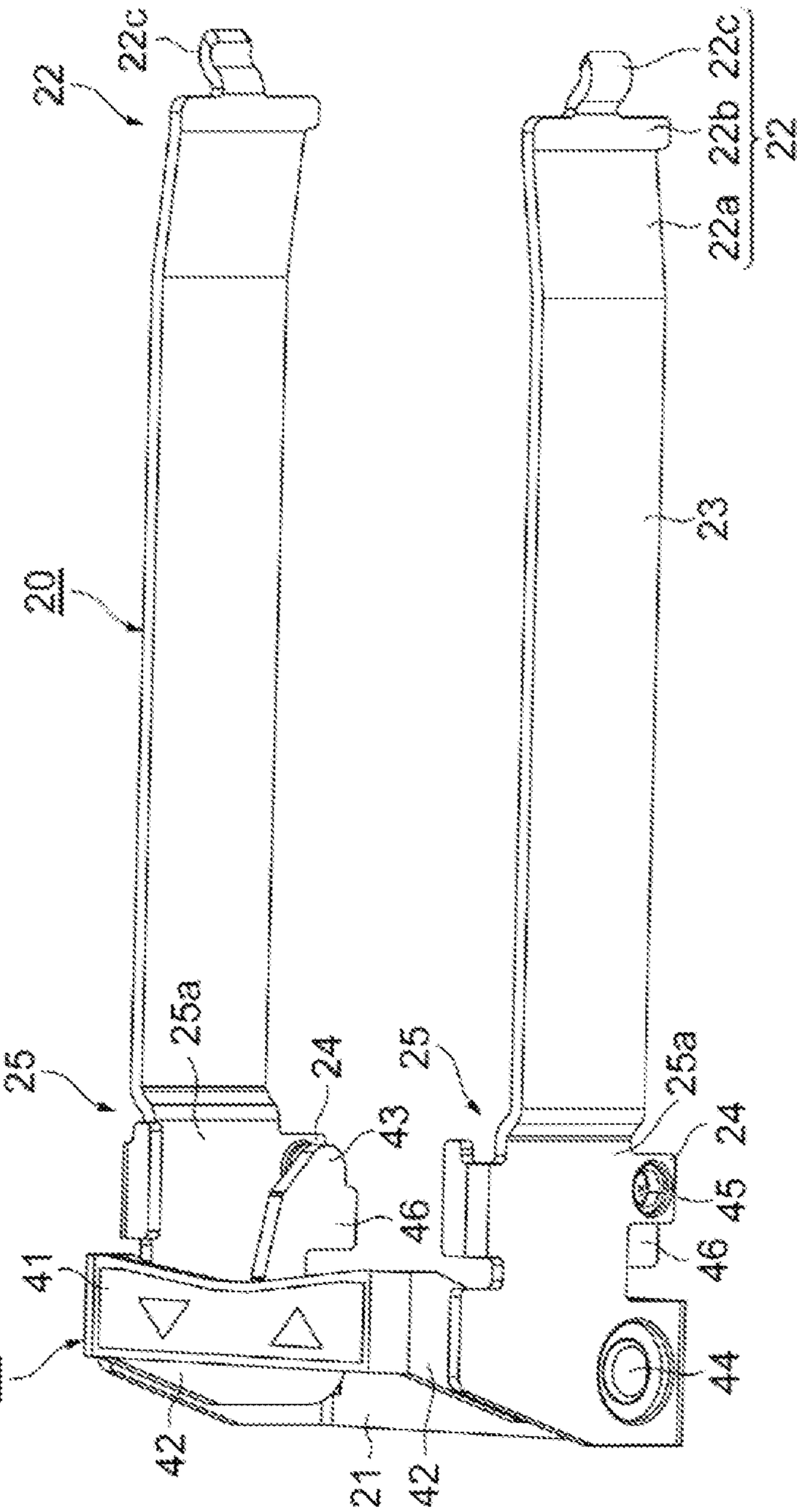


Fig.5

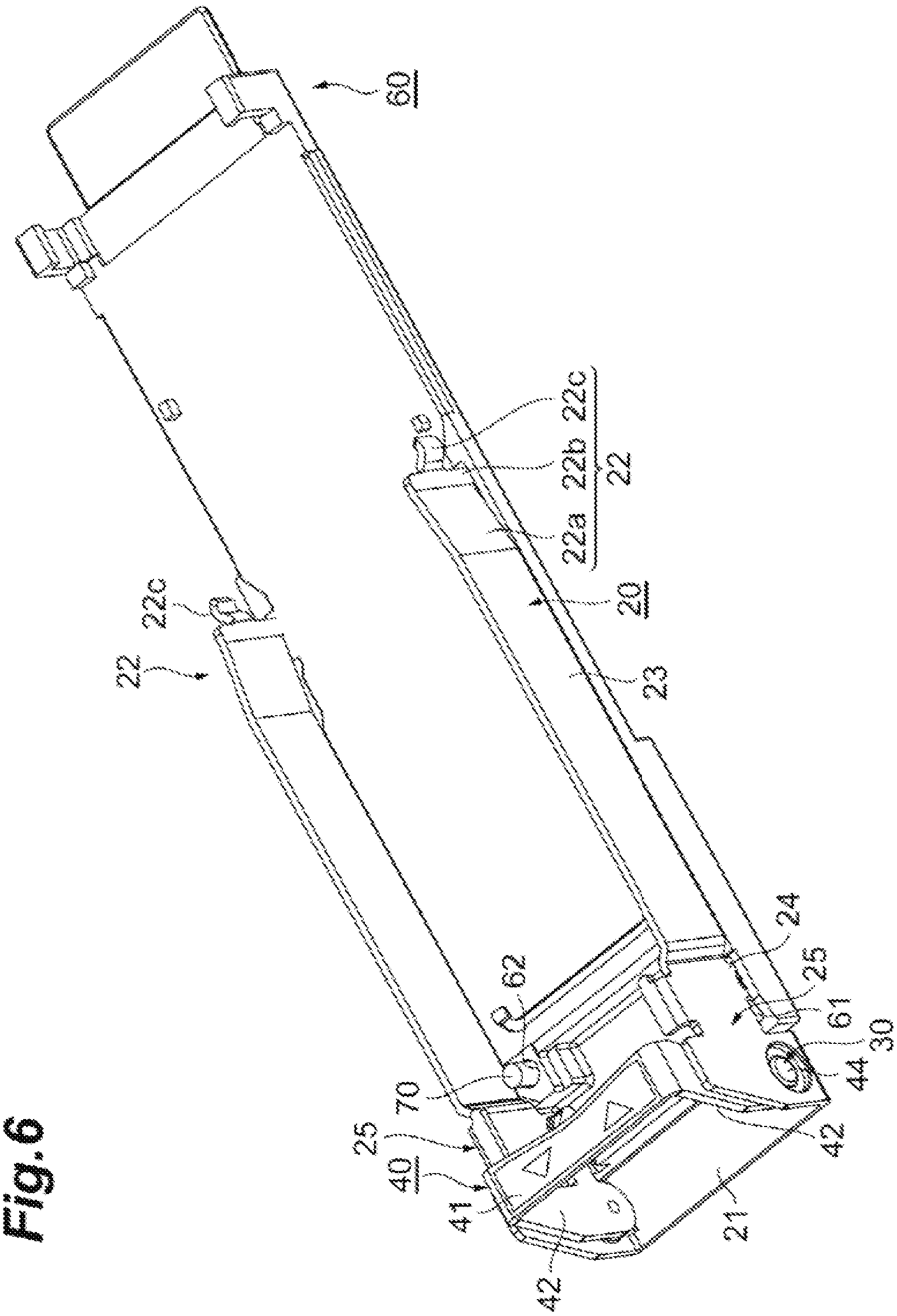
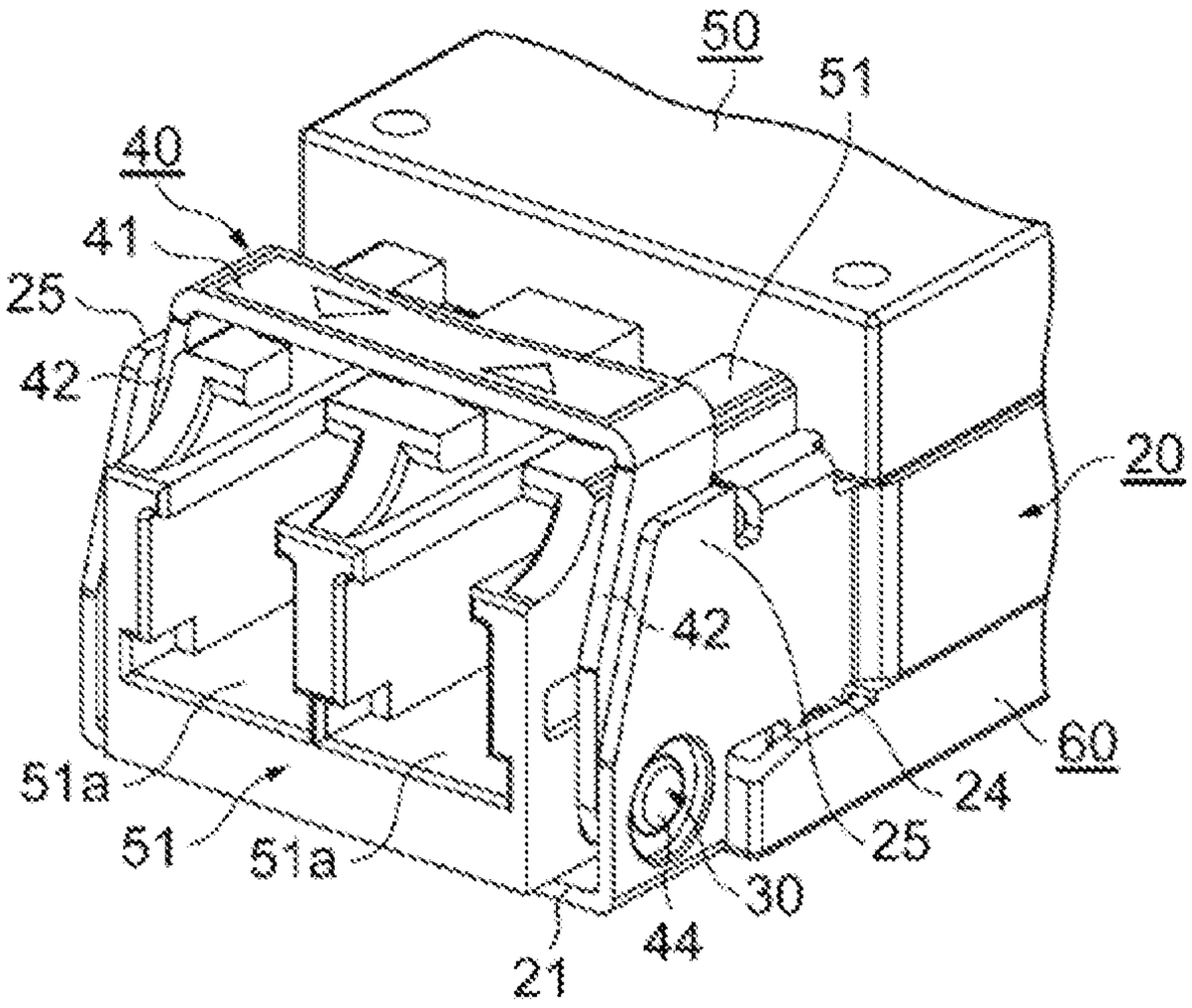


Fig.6

Fig.7A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51
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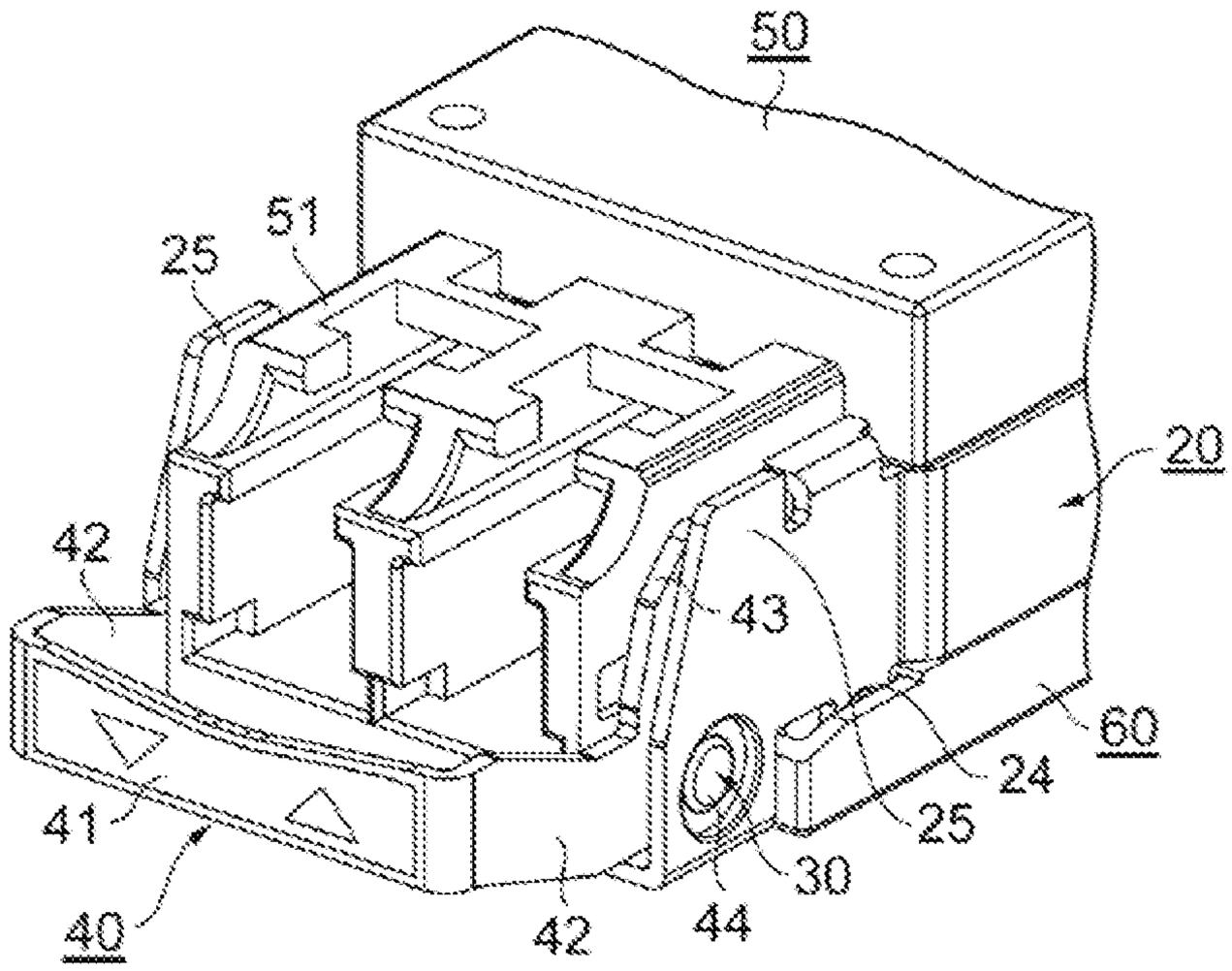
41
25
42
20
42
60
24
25
51a
51
51a
30
44
21

Fig.7B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25
51
20
42
43
60
24
25
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30
40
42
44

Fig.8A

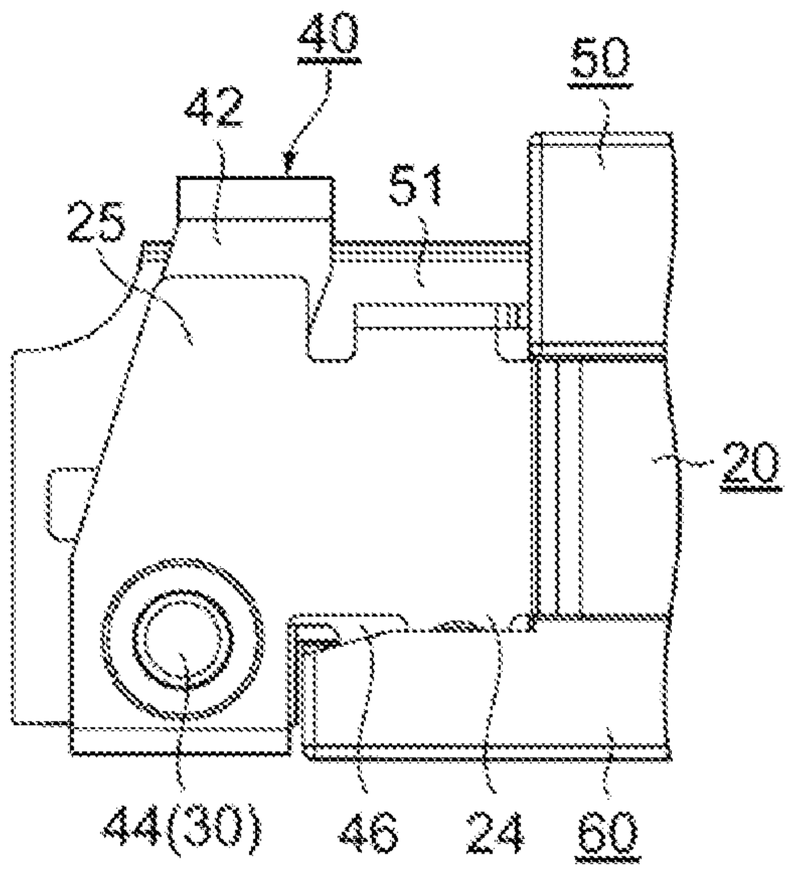


Fig.8B

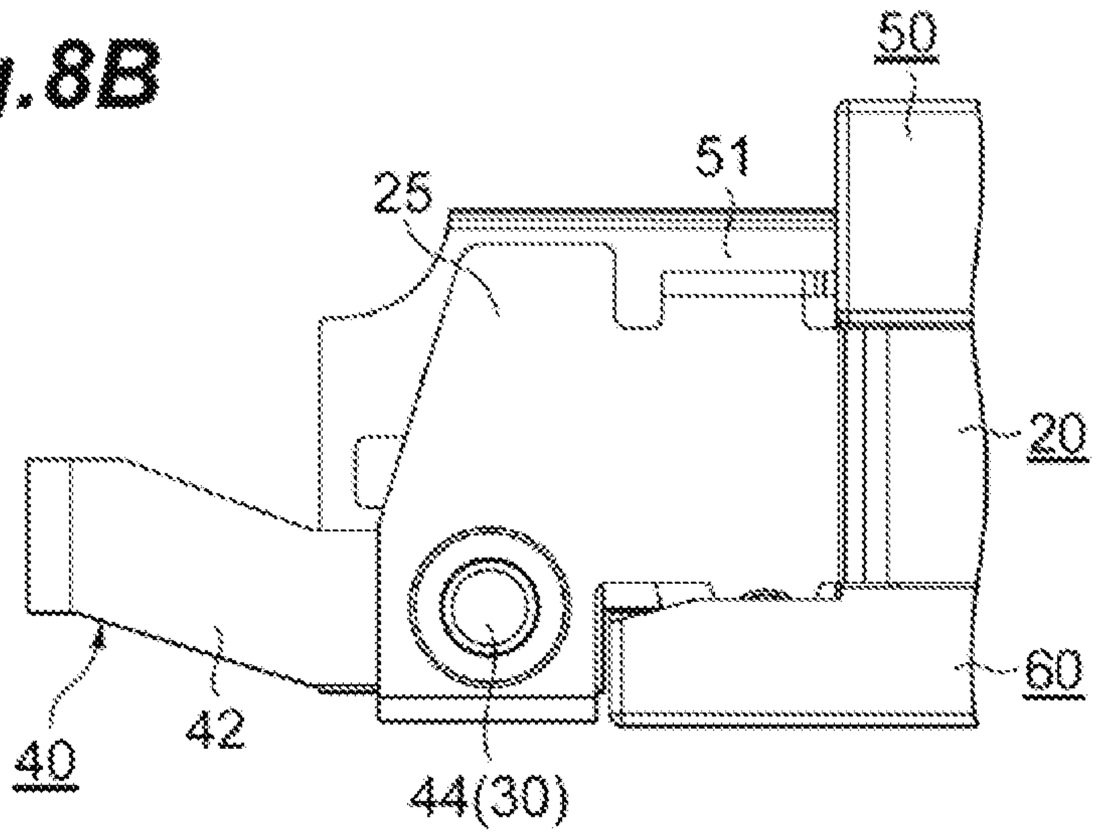


Fig.8C

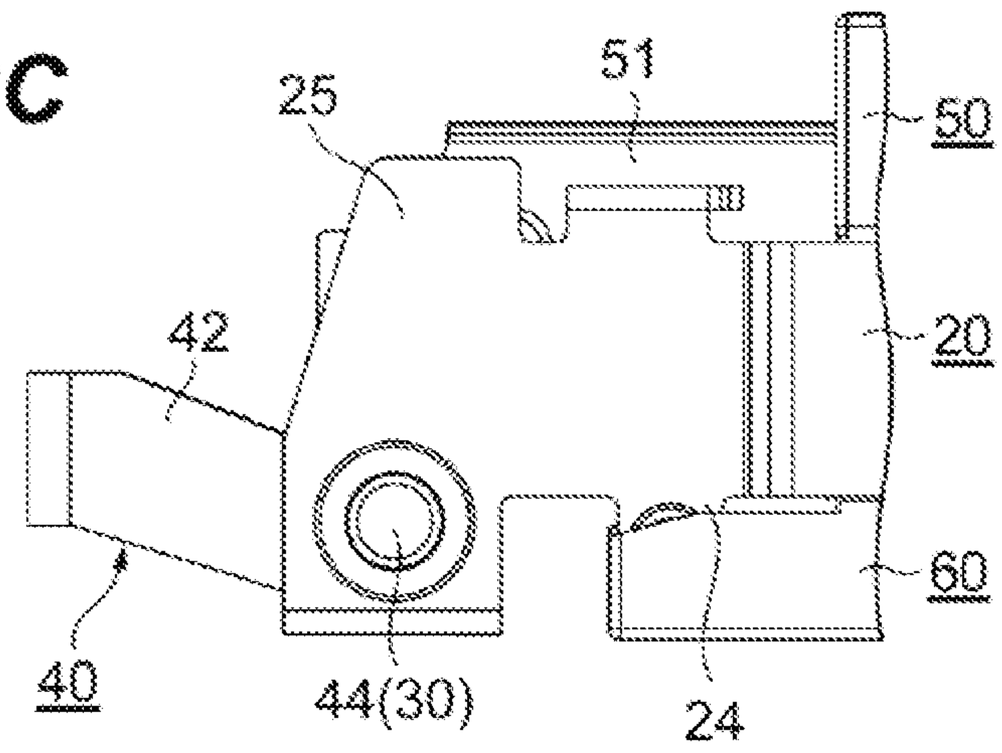


Fig.9A

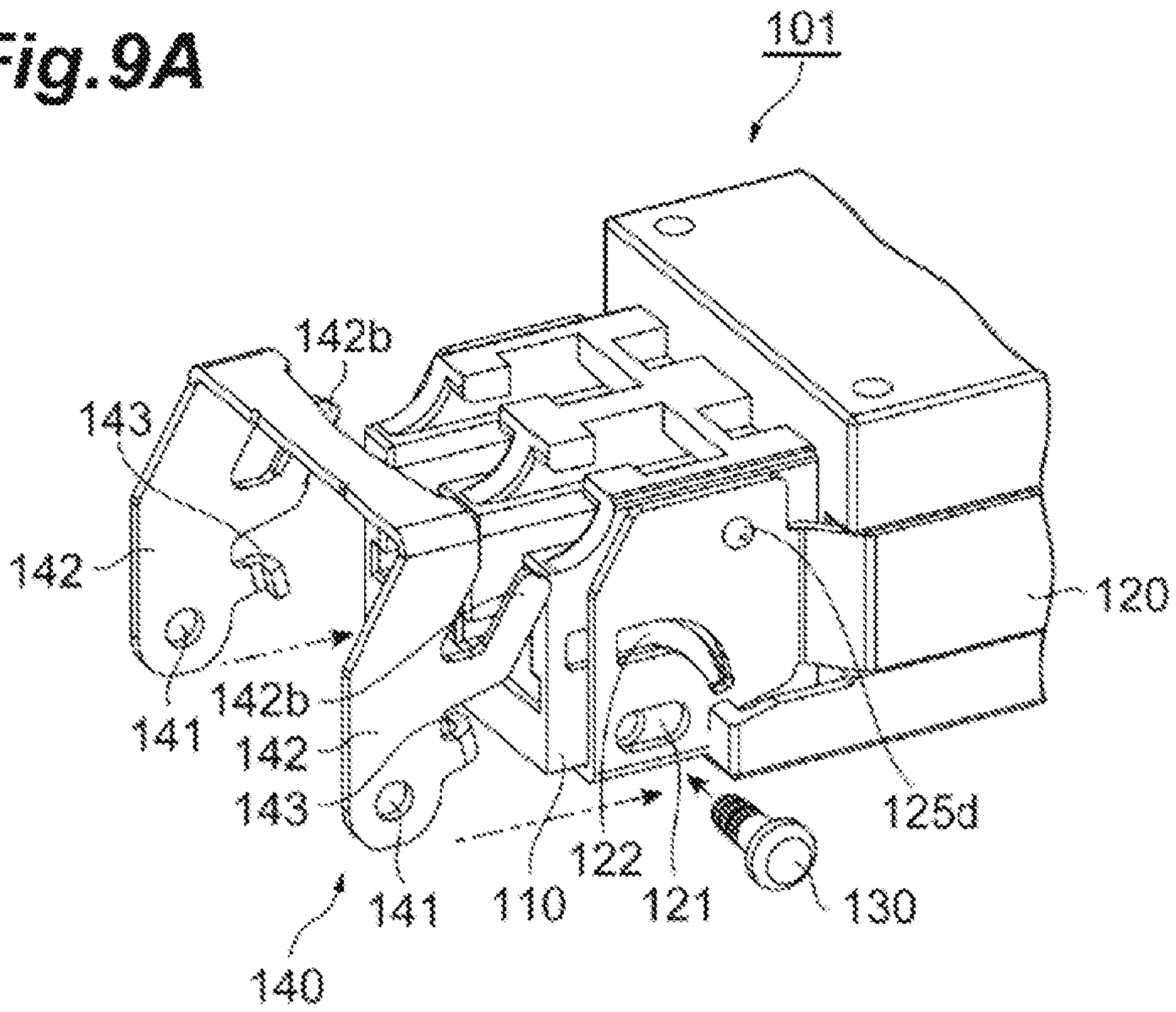
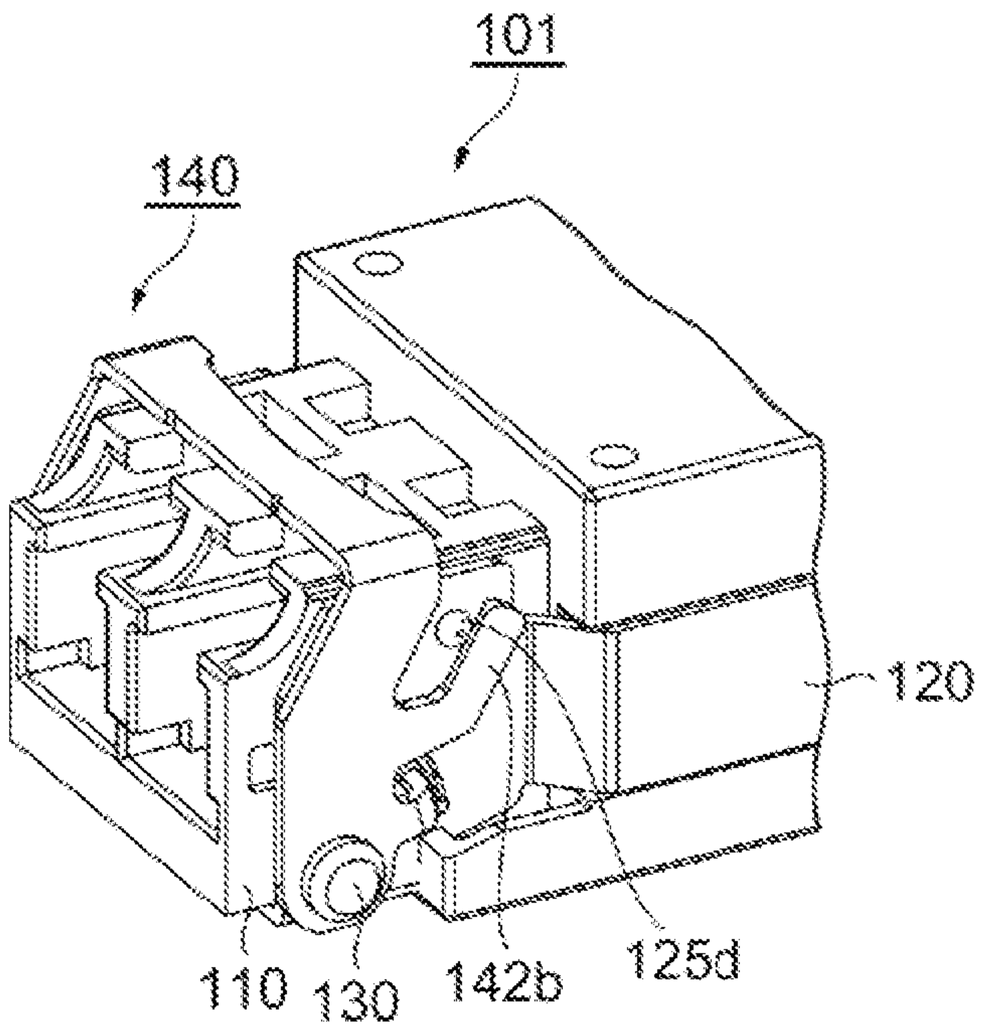

101
142b
143
142
141
142b
142
143
122
125d
120
141
110
121
130
140

Fig.9B


101
140
120
110
130
142b
125d

OPTICAL TRANSCEIVER HAVING BAIL WORKING INDEPENDENTLY OF LINEAR MOTION OF SLIDER

TECHNICAL FIELD

The present application relates to an optical transceiver, in particular, the application relates to a pluggable optical transceiver that implements a mechanism to be latched with and released from a cage provided in a host system.

BACKGROUND ART

One type of optical transceivers has a function to be latched with and released from a host system such as a router, a hub, and so on. Such an optical transceiver provides a housing, a slider, and a bail. The slider, which is assembled in both sides of the housing, slides along the longitudinal direction of the housing and the bail is assembled with the slider. A pivotal motion of the bail may cause the longitudinal slide of the slider, which may release the engagement between the housing with a cage.

A conventional mechanism of the bail and the slider thus described has a feature that the pivotal motion of the bail causes the linear motion of the slider. However, this mechanism has a disadvantage that, until the end of the pivotal motion of the bail, the optical transceiver is unable to be extracted from the cage of the host system. Thus, the conventional optical transceiver has a room to be improved in operability.

SUMMARY OF INVENTION

One aspect of the present application relates to a pluggable optical transceiver that is set within a cage provided in the host system. The optical transceiver includes at least a housing, a slider, and a bail. The slider is assembled with the housing and able to move linearly between a latching position and a releasing position. The optical transceiver is latched with the cage when the slider is set in the latching position, while, able to be released from the cage when the slider is in the releasing position. The bail is rotatable around an axis and assembled with the slider at the axis. A feature of the pluggable optical transceiver of the present application is that the rotation of the bail is independent of the linear motion of the slider. That is, even when the bail is rotated around the axis, the optical transceiver or the slider does not automatically release the optical transceiver from the housing. The rotation of the bail only sets the slider to be set in the releasing position; and, in order to release the optical transceiver from the cage, the slider is required to be linearly slid independent of the rotation of the bail.

BRIEF DESCRIPTION OF DRAWINGS

The foregoing and other purposes, aspects and advantages will be better understood from the following detailed description of a preferred embodiment of the invention with reference to the drawings, in which:

FIG. **1** is a perspective view showing an optical transceiver according to an embodiment of the present invention;

FIG. **2** is a front view of the optical transceiver shown in FIG. **1**;

FIG. **3** is a cross section of the optical transceiver taken along the line III-III appearing in FIG. **2**;

FIG. **4**A is an exploded view of a bail and a slider, and FIG. **4**B shows the bail assembled with the slider;

FIG. **5** is a perspective view of the bail assembled with the slider;

FIG. **6** is a perspective view of a latching/releasing mechanism including the bail and the slider assembled with the bottom housing;

FIG. **7**A illustrates a front portion of the optical transceiver when the bail is set in the first position where the optical transceiver is latched with the cage of the host system; while, FIG. **7**B shows the bail set in the second position where the optical transceiver is able to be released from the cage;

FIG. **8**A shows the bail set in the first position, FIG. **8**B shows the bail set in the second position but the slider is in a position not to release the engagement between the optical transceiver and the cage, and FIG. **8**C shows the slider slid to another position to release the engagement; and

FIGS. **9**A and **9**B illustrate a mechanism of the bail and the slider where the slider is able to work with the pivotal motion of the bail.

DESCRIPTION OF EMBODIMENTS

Next, details of embodiments of the present application will be described as referring to drawings. In the description of the drawings, numerals or symbols same with or similar to each other will refer to elements same with or similar to each other without duplicated explanations. However, it is apparent for ordinary artisans that embodiments of the invention should be considered in all respects as illustrative and not restrictive, the scope of the invention to be determined by the appended claims and their equivalents.

The optical transceiver **1** of the present embodiment is a type of, what is called, the pluggable optical transceiver plugged into a cage prepared in the host system. As illustrated in FIGS. **1** to **3**, the optical transceiver **1** primarily includes a box-shaped housing **10**, a slider **20**, and a bail **40**. The slider **20** is attached in respective sides of the housing **10** so as to freely move along the longitudinal axis of the housing **10**. The bail **40** is assembled with the slider **20** such that the bail **40** freely rotates around an axis **30**. The description below assumes that "front" is a side where the bail **40** is provided, while "rear" corresponds to the opposite.

The housing **10**, which comprises a top housing **50** and a bottom housing **60**, may be formed by die-casted aluminum, zinc, and so on; or by molded resin or plastic. The slider **20** is assembled with the bottom housing **60**. The housing **10** encloses optical assemblies and electronic circuits in a cavity formed by the top and bottom housings, **50** and **60**.

The top housing **50** provides in the front end thereof an optical receptacle **51** having two slots **51***a* each receiving optical connectors. One of slots **51***a* is for transmitting an optical signal to the optical connector, while, the other slot **51***a* is for receiving another optical signal from the optical connector. Mating a duplicated optical plug into the optical receptacle **51** and coupling two optical signals with optical devices installed within the housing **10**, the optical transceiver **1** realizes the full-duplex optical communication.

The slider **20** includes a pair of arms **23** and a beam **21** connecting the arms **23**. The beam **21**, which is set under the optical receptacle **51**, extends in parallel with the axis **30** of the bail **40**. The beam **21** stabilizes the sliding motion of the slider **20** along the longitudinal direction. The arms **23** each provides a latch **22** in a rear end thereof to set the optical transceiver **1** in the cage. Specifically, the arm **23** provides, in the rear end thereof the first surface **22***a* bent inwardly, the second surface **22***b* extending from the first surface **22***a* but bent outwardly, and a hook **22***c* projecting outwardly in the

tip end of the second surface **22***b*. The first and second surfaces, **22***a* and **22***b*, and the hook **22***c* constitute the latch **22**. The hook **22***c* is set within a pocket **52***a* formed in the top housing **50** when the slider **20** is set in the deep end thereof. The slider **20** set in the deep end is called as the latching position, while, the position of the slider **20** at which the hook **22***c* pushes the tab of the cage outwardly is called as the releasing position.

Although not illustrated in figures, the cage, which has a box shape with a front opening through which the optical transceiver **1** is set therein, in the host system provides tabs in respective sides thereof. The tabs face the latches **22** and protrude inside of the cage so as to be set between the first and second surfaces, **22***a* and **22***b*, of the latch **22**. Pulling the slider **20** frontward, the hook **22***c* pushes the latch in the cage outwardly to release the hooking between the tab and the latch **22**; accordingly, the optical transceiver **1** is able to be pulled out from the cage.

Referring to FIGS. **4**A and **4**B, the arms **23** of the slider **20** provide, in a front end thereof, respective front portions **25** each including a slab **25***a* with a tab **24** and an axis hole **25***c*. The tab **24** extends downward from the rear bottom edge of the slab **25***a*; while, the axis hole **25***c* is formed in the front bottom side of the slab **25***a*. The axis hole **25***c* accompanies with a donut rib **25***b* protruding inwardly around the axis hole **25***c*. The tab **24** provides another hole **25***e* also accompanied with a donut rib **25***d* protruding inwardly around the other hole **25***e*. The beam **21** connects the bottom edge of the slab **25***a* with the bottom edge of the other slab **25***a*. Referring to FIG. **6**, the tab **24** is set and movable within the front space **61** of the bottom housing **60**.

The bail **40**, as illustrated in FIGS. **2**, **4**A and **4**B, provides a pair of legs **42** and a bridge **41** bridging the legs **42**. The leg **42** is attached to the front portion **25** of the arm **23** such that, when the slider **20** is assembled with the housing **10**, the bridge **41**, the legs **42** and the beam **21** of the slider **20** surround the optical receptacle **51**. The leg **42** provides, in an end thereof, a limb **43** extending from an end **42***a* thereof toward a direction perpendicular to the direction of the leg **42**. The end **42***a* of the leg **42** further provides a projection **44** protruding outwardly; while, the limb **43** provides in an end **43***a* thereof another projection **45** also protruding outwardly. The former projection **44** has a pillared shape, while, the latter projection **45** has a rounded shape. Two projections, **44** and **45**, may be formed by coining and/or burring in the press working of a metal plate. The limb **43** further provides a tab **46** extending in substantially parallel to the leg **42**. The tab **46** is also set within the front space **61** in the bottom housing **60** similar to the tab **24** of the front portion **25** of the arm **23**.

Assembling the bail **40** with the slider **20** as bending the legs **42** inwardly, two projections, **44** and **45**, are set in respective holes, **25***c* and **25***e*. Because the projection **44** has the pillared shape and the axis hole **25***c* has a cylindrical inner surface, the projection **44** may smoothly rotate within the axis hole **25***c*. The projection **44** and the axis hole **25***c* becomes the axis of the rotation of the bail **40**.

Pushing the bridge **41** rearward around the axis **30**, the other projection **45** comes in contact with the donut rib **25***d* around the other hole **25***e*. Further rotating the bridge **41**, the projection **45** is snapped within the other hole **25***e*. The rounded shape of the projection **45** facilitates the snapping motion of the projection **45**.

The tab **24** of the front portion **25** of the arm **23** is, as already explained, movable in the front space **61** of the bottom housing **60**. The front space **61** also provides screw holes **62** into which screws to assemble the bottom housing **60** with the top housing **50**, as illustrated in FIGS. **3** and **6**.

Assembling two housings, **50** and **60**, the slider **20** assembled with the bail **40** is securely set between two housings, **50** and **60**.

Next, the sliding mechanism of the slider **20** triggered by the rotation of the bail **40** will be explained.

When the optical transceiver **1** is tightly set within the cage, the slider **20** is deeply set within the housing **10** such that the hook **22***c* in the tip end of the latch **22** is set in the pocket **52***a* of the top housing **50**, which the tab in the cage protrudes within the cage and is hooked with the latch **22**. This position of the slider **20** is called as the latching position. In this case, the bridge **41** is set above the optical receptacle **51**, and the legs **42** are vertically set between the front portion **25** of the arm **23** and the optical receptacle **51**.

In addition, the rounded projection **45** of the limb **43** is snapped within the hole **25***e* and the tab **46** is set in the front space **61** of the bottom housing **60**. Under such conditions of the tab **46**, the motion of the slider **20** along the longitudinal direction may be effectively prevented because the front edge **46***a* of the tab **46** abuts against the front wall **61***a* of the space **61**. Accordingly, the front wall **61***a* shows a function of a stopper for the longitudinal motion of the slider **20**. Rotating the bail **40** around the pillared projection **44** as illustrated in FIGS. **7**B and **8**B, the snap-in between the rounded projection **45** and the hole **25***e* is released, and the tab **46** of the limb **43** is split out from the front space **61** of the bottom housing **60**.

Then, as illustrated in FIG. **8**C, pulling the slider **20** frontward to release the engagement of the tab of the cage with the latch **22** of the slider **20**, the optical transceiver **1** may be released from the cage. Further pulling the slider **20** frontward, the front surface **25***f* of the tab **24** abuts against the front wall **61***a* of the front space **60**, which prevents the slider **20** from being slipped off from the housing **10**. Moreover, the front surface **25***f* of the tab **24** presses the front wall **61***a* frontward, which facilitates the pull-out of the transceiver **1** from the cage.

Thus, in the optical transceiver **1** of the present embodiment, when the bail **40** is set in the first position shown in FIG. **8**A, that is, the bridge **41** is set in the above of the optical receptacle **51**, the tab **46** of the limb **43** in the front surface **46***a* thereof abuts against the front wall **61***a* of the bottom housing **60** to prevent the optical transceiver from being slipped off from the cage. When the bail **40** is in the second position shown in FIG. **8**B, that is, the bail **40** is set in front of the optical receptacle **51**, and the slider **20** is able to slide frontward. Thus, the sliding motion of the slider **20** is independent of the rotation of the bail **40**. When the tab **46** is once slipped off from the front space **61** of the bottom housing **60** by the rotation of the bail **40** such that the contact against the front wall **61***a* is released, the slider **20** becomes movable even when the bail **40** is in a midway of the rotation. In such a status, the other tab **24** in the front portion of the arm **23** becomes a stopper to prevent the slider **20** from being slipped off from the housing **10** by making the front surface **25***f* of the tab **24** in contact with the front wall **61***a* of the bottom housing **60**. When the optical transceiver **1** is extracted from the cage, the front surface **25***f* of the tab **24** abuts against the front wall **61** to facilitate the extraction.

A conventional pluggable transceiver, where the slider in the sliding motion thereof is tied with the rotation of the bail, that is, the rotation of the bail automatically induces the sliding motion of the slider, which causes an unintentional extraction of the optical transceiver from the cage. The present optical transceiver, in particular, the present mechanism of the bail and the slider makes the sliding motion of

the slider independent of the rotation of the bail, which effectively prevents the optical transceiver from unintentional extraction from the cage. Moreover, even when the slider is pulled as the bail **40** is set in the first position of FIG. **8**A, the tab **46** shows an effective function to prevent the slider **20** from sliding to the position shown in FIG. **8**C.

FIGS. **9**A and **9**B show mechanism of the bail and the latch of a conventional pluggable transceiver **101** that provides a slider **120** and a bail **140** rotatable by a pin **130** as a center of the rotation. The pin **130** is press-fit into the housing **110** as piercing a hole **141** of the legs **142** and another hole **121** of the slider **120**. The press-fitting of the pin **130** is, in addition to a fact that it requires a specific tool and an apparatus, irrevocable process. Once the pin **130** is press-fit into the housing **110**, the housing is unable to be recycled even when components except for the housing become apparent to have failures. Thus, the conventional mechanism of the bail **140** and the slider **120** causes lesser production cost.

The bail **40** and slider **20** of the present embodiment omits the press-fit pin **130** because, as shown in FIGS. **4**A and **4**B, the pillared projection **44** set in the axis hole **25***c* becomes the center of the rotation of the bail **40**. The conventional bail **140** shown in FIGS. **9**A and **9**B is necessary to provide a hook **143** and a tab **142***b*. The hook **143**, guided within an arched groove **122**, causes the sliding motion of the slider **120** as the bail **140** rotates around the axis of the pin **130**. The hook **142***b* induces the snap action by getting over the rounded projection **125***d*. Thus, the conventional bail **140** requires a complicated structure.

Referring to FIG. **2**, the bail **40** of the present embodiment, at least a portion thereof, is set between the optical receptacle **51** and the slider **20**, which prevents the bail **40** from being slipped out from the optical transceiver **1**. In addition, when the bail **40** is fully pivoted in the last position shown in FIG. **8**C, the rounded projection **45** is set in the hole **25***e* running over the donut rib **25***d* around the hole **25***e*, which effectively sets the bail **40** within the hole **25***e* and prevents the bail **40** from backward rotation.

Moreover, referring to FIG. **3**, the optical transceiver **1** of the embodiment has a height H**1** of the center O of the pillared projection **44** measured from the bottom of the housing **10** substantially equal to the height H**2** of the front wall **61***a* of the front space **61** of the bottom housing **60**. That is, the level of the center of the pillared projection **44** is substantially equal to the top level of the front wall **61***a*. This arrangement makes the height of the tab **46**, or the length of the front surface **46***a* of the tab **46**, in minimum to show the function of the reliable stopper for the illegal motion of the slider **20**.

In addition, the rounded projection **45**, or the limb **43** is always hidden by the front portion **25***a* of the arm **23** independent of the status of the bail **20**. Referring to FIGS. **9**A and **9**B, the conventional mechanism to show the snap action of the bail **140** exposes the tab **142***b* which possibly causes an illegal action of the bail **140** when the bail **140** is manually manipulated.

While, particular embodiments of the present invention have been described herein for purposes of illustration, many modifications and changes will become apparent to those skilled in the art. For instance, the optical transceiver **1** thus described provides a pair of the sliders **20** and the bridge **21** bridging the sliders **20**. However, the bridge **21** is omissible. The slider **20** provides two holes, **25***c* and **25***e*, in the front portion **25***a* thereof; but, these holes, **25***c* and **25***e*, are replaceable to concaves or dimples to receive the pillared projection **44** and the rounded projection **45**, respectively. The slider **20** of the embodiment provides the arms **23**, the latches **22**, and the front portions **25***a*; but, the detail shape of the slider **20** is optional.

The embodiment above described provides the pillared projection in the bail and the hole **25***c* in the slider **20** to form the center axis **30** of the rotational motion of the bail **20**. However, the relation of the projection and the hole may be reversible. That is, the bail may provide a hole, while, the slider may provide the projection. Further, the bail **40** provides the rounded projection **45**, while, the slider **20** provides the hole **24***e* receiving the rounded projection **45**. However, this relation of a projection and a hole may be reversible. The bail **40** may provide a hole or a dimple, while, the slider **20** may provide a projection set within the hole or the dimple to show the snap action.

Finally, the embodiment thus described provides the top housing **50** and the bottom housing **60** assembled with the top housing **50** to constitute the housing **10**. However, the optical transceiver **1** is unnecessary to divide the housing **10** into two parts. The housing **10** having a shape able to be inserted into the cage is the only the necessity condition for the pluggable optical transceiver.

Accordingly, the appended claims are intended to encompass all such modifications and changes as fall within the true spirit and scope of this invention.

The invention claimed is:

1. A pluggable optical transceiver set within a cage provided in a host system, comprising:

a housing including an optical receptacle and a stopper, the optical receptacle receiving an external optical connector;

a slider set in the housing, the slider being linearly movable between a latching position and a releasing position, the optical transceiver being latched with the cage when the slider is in the latching position and released from the cage when the slider is in the releasing position; and

a bail that is capable of rotating between a first position and a second position around an axis and assembled with the slider at the axis,

wherein, when the bail is at the first position, the optical receptacle is capable of receiving the external optical connector and the slider is prohibited from moving between the latching position and the releasing position by abutting a tab provided in the bail against the stopper of the housing,

wherein, when the bail is at the second position, the slider is capable of moving linearly between the latching position and the releasing position, and

wherein the rotation of the bail is independent of the linear motion of the slider.

2. The pluggable optical transceiver of claim **1**,

wherein the slider has another tab abutting against the stopper of the housing when the bail is in the second position, the another tab preventing the slider from being disassembled with the housing.

3. The pluggable optical transceiver of claim **1**,

wherein the bail has a pair of legs and a bridge that connects the legs, and the slider has a pair of arms and a beam that connects the arms, and

when the bail is set at the first position, the bridge, the legs, and the beam surround the optical receptacle.

4. The pluggable optical transceiver of claim **3**,

when the bail is set at the second position, the bridge is set in front of the optical receptacle and prevents the optical receptacle from receiving the external optical connector.

5. The pluggable optical transceiver of claim 3,

wherein the legs provide a pillared projection in an end portion thereof opposite to a portion connected to the bridge, the pillared projected being inserted in an axis hole provided in the slider, the pillared projection and the axis hole forming the axis around which the bail rotates.

6. The pluggable optical transceiver of claim 5,

wherein the legs of the bail each provides a limb extending from the end portion thereof toward a direction intersecting a direction along which the legs extend, the limb providing a rounded projection in an end portion thereof, and

wherein the arms of the slider each provides an opening that receives the rounded projection, and

wherein the bail is set in the first position as a snap action of the rounded projection of the leg into the opening of the arm.

7. The pluggable optical transceiver of claim 6,

wherein the opening of the slider provides a donut rib therearound.

8. The pluggable optical transceiver of claim 6,

wherein the limb provides a tab including a front edge that abuts against the stopper of the housing when the bail is set at the first position.

9. The pluggable optical transceiver of claim 6,

wherein the slider provides a tab including a front edge that abuts against the stopper of the housing when the bail is set at the second position.

10. The pluggable optical transceiver of claim 9,

wherein the limb provides a tab including a front edge that abuts against the stopper of the housing when the bail is set at the first position, and

wherein the front edge of the limb is in front of the front edge of the slider when the bail is set at the first position.

11. The pluggable optical transceiver of claim 6,

wherein the legs each provides a limb extending from the end portion thereof toward a direction intersecting a direction along which the leg extends, the limb providing a rounded projection in an end portion thereof, and

wherein the arms of the slider each provides a depression that receives the rounded projection of the leg by the snap action of the rounded projection of the limb into the depression.

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